Hazard Profile - Drought

Summary

- The hazard – Drought is a prolonged period of low precipitation severe enough to reduce soil moisture, water and snow levels below the minimum necessary for sustaining plant, animal, and economic systems. A natural part of the climate cycle, droughts can reduce water supply, threaten crops that rely on natural precipitation, and increase the threat of wildfires.

- Previous occurrences – Washington has a history of drought, including several that lasted more than a single season. The worst two on record occurred in 1997 and 2001; the most recent event in 2005 was not as severe.

- Probability of future events – At this time, reliable forecasts of drought are not attainable for temperate regions of the world more than a season in advance. However, based on a 100-year history with drought, the state as a whole can expect severe or extreme drought at least 5 percent of the time in the future, with most of eastern Washington experiencing severe or extreme drought about 10 to 15 percent of the time.

- Jurisdictions at greatest risk – Nine counties that meet criteria including percentage of time in drought, water use for crop irrigation or due to growth, and potential inability to deal with financial impacts of drought on their communities.

- Special note – This profile will not attempt to estimate potential losses to state facilities due to drought. This hazard poses little threat to people and the built environment, but can pose significant damage to the state's economy.

Introduction[1, 2, 3, 4, 5, 6]

Drought is a prolonged period of reduced precipitation severe enough to reduce soil moisture, water and snow levels below the minimum necessary for sustaining plant, animal, and economic systems. Droughts are a natural part of the climate cycle. In the past century, Washington State has experienced a number of drought episodes, including several that lasted for more than a single season – 1928 to 1932, 1992 to 1994, and 1996 to 1997.

Unlike most states, Washington has a statutory definition of drought (Revised Code of Washington Chapter 43.83B.400). According to state law, an area is in a drought condition when:

- The water supply for the area is below 75 percent of normal.

- Water uses and users in the area will likely incur undue hardships because of the water shortage.

Drought can have a widespread impact on the environment and the economy, depending upon its severity, although it typically does not result in loss of life or damage to property, as do other natural disasters.

The National Drought Mitigation Center at the University of Nebraska-Lincoln uses three categories to describe likely drought impacts:

- Agricultural – Drought threatens crops that rely on natural precipitation.
- Water supply – Drought threatens supplies of water for irrigated crops and for communities.
- Fire hazard – Drought increases the threat of wildfires from dry conditions in forest and rangelands.

Additionally, drought threatens the supply of electricity in our state. Hydroelectric power plants generated nearly three-quarters of the electricity produced in Washington State in 2000. When supplies of locally generated hydropower shrink because of drought, utilities seek other sources of electricity, which can drive up prices even as supply is reduced.

Unlike most disasters, droughts normally occur slowly but last a long time. Drought conditions occur every few years in Washington. The droughts of 1977 and 2001, the two worst in state history, provide good examples of how drought can affect the state (see details below).

On average, the nationwide annual economic impacts of drought – between $6 billion and $8 billion annually in the United States – are greater than the impacts of any other natural hazard. They occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and environmental impacts are also significant, although it is difficult to put a precise cost on these impacts.

Drought affects groundwater sources, but generally not as quickly as surface water supplies, although groundwater supplies generally take longer to recover. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry; shallow wells are more susceptible than deep wells. About 16,000 drinking water systems in Washington get water from the ground; these systems serve about 5.2 million people.

Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

A drought directly or indirectly affects all people and all areas of the state. A drought can result in farmers not being able to plant crops or the failure of the planted crops.

This results in loss of work for farm workers and those in related food processing jobs. Other water or electricity-dependent industries commonly shut down all or a portion of their facilities, resulting in further layoffs. A drought can spell disaster for recreational companies that use water (e.g., swimming pools, water parks, and river rafting companies) and for landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. Also, people could pay more for water if utilities increase their rates. With much of Washington's energy coming from hydroelectric plants, a drought can mean more expensive electricity from dams and probably higher electric bills.

Probability of Future Occurrence[7]

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on a global scale.

In temperate regions, including Washington, current long-range forecasts of drought have limited reliability. In the tropics, empirical relationships have been demonstrated between precipitation and El Niño events, but few such relationships have been demonstrated above the 30º north latitude are yet understood; Washington sits between 45.30º and 49º north latitude. Meteorologists do not believe that reliable forecasts are attainable at this time a season or more in advance for temperate regions.

Based on the state's history with drought from 1895 to 1995 (see pages 14-17 for more), the state as a whole can expect severe or extreme drought at least 5 percent of the time in the future. All of eastern Washington, except for the Cascade Mountains eastern foothills, can expect severe or extreme drought 10 to 15 percent of the time. The east slopes of the Cascades and much of western Washington can expect severe or extreme drought from 5 to 10 percent of the time.

Comparing the droughts of 1977 and 2001[8, 9]

The Northwest typically has a summer drought with very little summer rainfall. In Seattle, the average rainfall in July/August is only about one inch while it is five to six inches in November and December. Much of Eastern Washington is high desert with annual rainfall of only seven inches in Quincy. With snow dependent irrigation, this desert becomes extremely valuable and productive farmland for a wide variety of crops.

The major causes of droughts in Washington are either low snow accumulations from either low precipitation or warm winter temperatures; or by warm weather in the late winter-early spring that causes early melt of the snowpack.

Most of the state's annual precipitation occurs during the winter. Precipitation in the Cascade Mountains is normally stored as snow that slowly melts during the spring and summer, maintaining stream and river flows. This is the primary source of water for irrigation and municipal use.

Where the snow falls affects the nature of a drought. The Columbia River provides most of the energy for hydroelectric power and irrigation for the Columbia Basin Project and farms in the basin. The Columbia receives large amounts of its flow from mountainous areas in British Columbia. In the southern Cascade Mountains of Washington, the Yakima River basin is particularly influenced by fluctuating snow levels.

The 1977 drought was the worst on record, but the 2001 drought came close to surpassing it in some respects. The table on the following page has data on how the two droughts affected Washington by late September of their respective years.

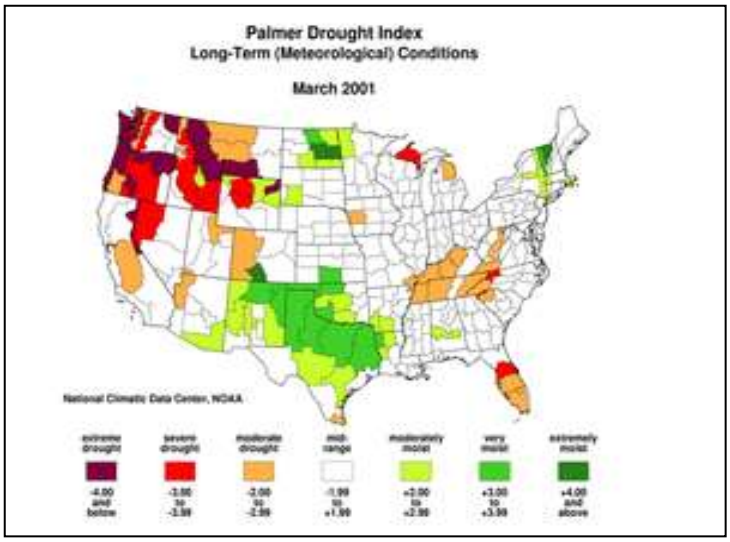
Table 1. Comparison of Impacts of 1977 Drought and 2001 Drought Events

	1977 Drought	2001 Drought
Precipitation	Precipitation received at most locations ranged from 50 to 75 percent of normal levels, and in parts of Eastern Washington as low as 42 to 45 percent of normal.	Precipitation was 56 to 74 percent of normal. US Bureau of Reclamation – Yakima Project irrigators received only 37 percent of their normal entitlements. Elsewhere, water users found their supply interrupted much earlier than in a typical year. At the end of the irrigation season, the U.S. Bureau of Reclamation's five reservoirs stored only 50,000 acre-feet of water compared with 300,000 acre-feet typically in storage.
Wildland Fire	1,319 wildland fires burned 10,800 acres. State fire-fighting activities involved more than 7,000-man hours and cost more than $1.5 million.	1,162 wildland fires burned 223,857 acres. Firefighting efforts cost the state $38 million and various local, regional and federal agencies another $100 million.
Fish	In August and September 1977, water levels at the Goldendale and Spokane trout hatcheries were down. Fish had difficulties passing through Kendall Creek, a tributary to the north fork of the Nooksack River in Whatcom County.	A dozen state hatcheries took a series of drought-related measures, including installing equipment at North Toutle and Puyallup hatcheries to address low water flow problems.
Emergency Water Permits	Department of Ecology issued 517 temporary ground-water permits to help farmers and communities drill more wells.	Department of Ecology issued 172 temporary emergency water-right permits and changes to existing water rights.
Economic Impacts	The state's economy lost an estimated $410 million over a two-year period. The drought hit the aluminum industry hardest, with major losses in agriculture and service industries, including a $5 million loss in the ski industry. 13,000 jobs were lost because of layoffs in the aluminum industry and in agriculture.	The Bonneville Power Administration paid more than $400 million to electricity-intensive industries to shut down and remain closed for the duration of the drought. Thousands lost their jobs for months including 2,000-3,000 aluminum smelter workers at the Kaiser and Vanalco plants. The drought reduced energy supplies, and combined with instability in energy markets elsewhere in the country, contributed to the permanent job losses. Federal agencies provided more than $10.1 million in disaster aid to growers. More than $7.9 million in state funds paid for drought-related projects; these projects enabled the state to provide irrigation water to farmers with junior water rights and to increase water in fish-bearing streams.

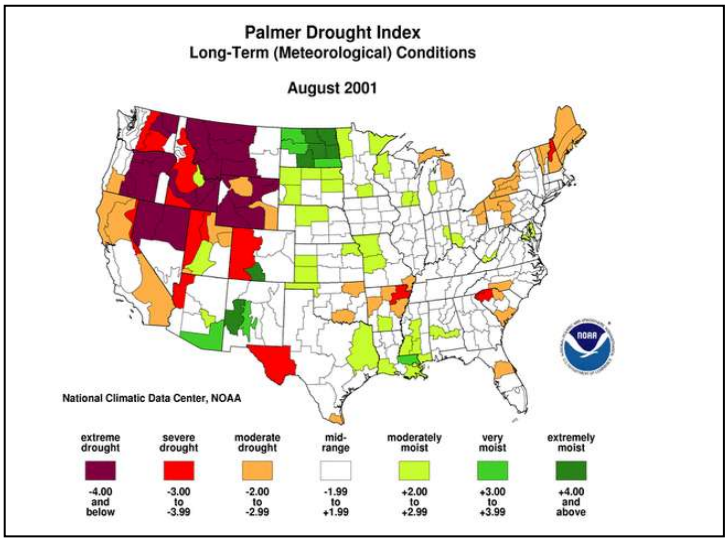
2001 Drought[10]

As the state began water year 2001 (October 1, 2000 – September 30, 2001), there was little reason to expect anything out of the ordinary. Climatologists had predicted cooler, wetter-than-normal weather for the Pacific Northwest.

While November and December 2000 were unusually dry, most experts assumed the typical heavy snow and rainfall levels would begin again in January 2001. However, the dry weather pattern continued through January and February, not returning to normal until March.



By mid-March, nearly every corner of the state was suffering from a water supply deficit. Between November 2000 and March 2001, the state received just 60 percent of normal rain and snowfall. The outlook for summer water supplies looked bleak. Federal, state and local officials worried low river flows would disrupt state hydroelectric power production and that dwindling water supplies would put various threatened and endangered fish species at risk.



On March 14, 2001, Gov. Gary Locke authorized the Department of Ecology to declare a statewide drought emergency; Washington was the first Northwest state to make such a declaration, which remained in effect until December 31, 2001.

The central part of the state, from the crest of the Cascade Mountains to the east banks of the Okanogan and Columbia Rivers, suffered the most from water shortages.

The Palmer Drought Index for March 2001, (top graphic, above), graphically displays the height of drought conditions in Western Washington; the August 2001 index, (bottom graphic, above), shows the height of drought conditions in Eastern Washington. These maps provide a comparison of drought conditions in Washington with those in the rest of the lower 48 states at the time.

The scale used for the Palmer Drought Index characterizes severe drought as having likely crop or pasture losses, very high fire risk, water shortages common with water restrictions imposed. An extreme drought has major crop and pasture losses, extreme fire danger, and widespread water shortages or restrictions.

Among the impacts of the 2001 drought:

- *Energy* – The drought decreased river flows, resulting in less electrical generation and tighter power supplies. Available out-of-state power was extremely expensive, causing higher rates and financial emergencies at many of the state's utilities. Bonneville Power Administration paid to keep electricity-intensive industries including aluminum smelters shut down. Many small-scale power generators were placed into emergency service throughout the state.

- *Agriculture* – With stream flows below half of normal and groundwater levels threatened, there was significantly less water available for irrigation; irrigated land produces about 70 percent of the state's crops. The Governor's drought order authorized the Department of Ecology to exercise emergency powers to:
    - Issue temporary emergency water-rights permits and change existing water rights for farmers in 13 counties.
    - Reduce mandated minimum stream flows in the Columbia River basin, helping 300 farmers and saving several million dollars worth of crops.
    - Authorize emergency wells in the Yakima River basin.
    - Lease water to improve instream flows and subsequently improve water supplies for farmers in the Roza irrigation and Kittitas reclamation districts.

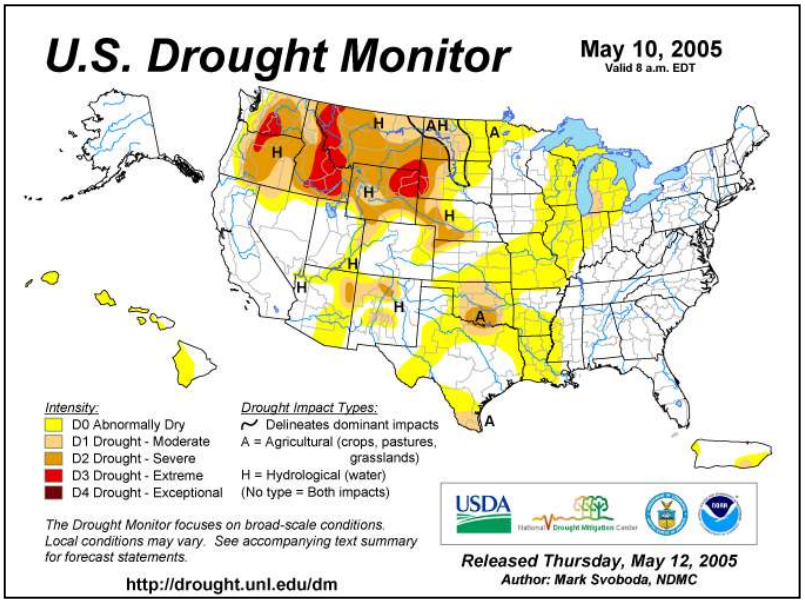
- *Fish* – As the drought progressed, reduced stream flows caused numerous fish-passage problems on the American River, Rattlesnake Creek, and other Yakima River tributaries. Some fish stocks were lost. To help Columbia River fish populations, the Bonneville Power Administration paid growers in the basin to remove 75,000 acres from agricultural production; this kept additional water in the river during the most critical drought months. Improvements were made at a number of hatcheries, and salmon and steelhead were moved out of two hatcheries that experienced water problems.

- *Wildland fire* – Because of low moisture levels in forests, dry weather during the summer of 2001 resulted in 14 major fires that burned more than 178,000 acres of forest; total area burned was 223,857 acres.

2005 Drought[11]

Water year 2005 – October 1, 2004, through September 30, 2005 – got off to a good start. October precipitation ranged between normal to well-above normal for all but the north Puget Sound region. However, precipitation was below or much below average November through February for much of the state, and the fall and winter months were extremely warm, which adversely affected the state's mountain snow pack. A warm

mid-January storm removed much of the remaining snow pack. When February turned out to be warm and dry, it appeared the state might face a potentially serious drought in 2005.



By early March, projections showed Washington might be facing a drought as bad as or worse than the 1977 drought, the worst on state record. Governor Christine Gregoire authorized the Department of Ecology to declare a statewide drought emergency on March 10, 2005. The emergency proclamation expired on December 31, 2005.

Following the drought declaration, the Governor submitted a $12 million supplemental budget request the state legislature approved that provided funds for buying water, improving wells, implementing other emergency water-supply projects, and hiring temporary state staff to respond to the drought emergency, conduct public workshops and undertake drought-related studies

Potential impact on power generation

State officials initially were concerned the early melting of mountain snow pack might mean water supplies would not be enough to meet typical energy demands. In March, the water supply forecast was 66 percent of normal, signaling an extremely poor water year and a possible reduction in electricity production. The forecast improved in April and following months. By late spring, due to record precipitation in March and April water filled reservoirs to about 95 percent of capacity, more than enough to meet projected electricity demands.

Potential impact on agriculture

Despite projected drought impacts of up to $300 million, unexpected spring rains combined with reallocation of water and conservation measures by farmers largely mitigated the drought's impacts. Harvest of most crops was near normal levels. Rain damaged some crops, prevented harvest of hay, and limited field work, and cool spring weather resulted in poor pollination of some fruit crops. Winter wheat harvest was near normal statewide but spring wheat harvest was down largely due to reduced planting in anticipation of the drought. While statewide harvests were near normal, local farmers who did not receive the spotty rains experienced poor harvests.

Stream flows on the Columbia River main-stem were sufficient so that no stoppage of water diversions for irrigation were required.

In October, Governor Gregoire requested agricultural disaster designations from the U.S. Secretary of Agriculture because of significant crop damage from drought. The following counties were included in the disaster request: Asotin, Benton, Chelan, Clark, Columbia, Cowlitz, Douglas, Franklin, Kittitas, Klickitat, Lincoln, Skamania, Walla Walla, Wahkiakum, and Yakima.

Potential impact on drinking water

To reduce the potential impact caused by a reduction in the quantity and quality of drinking water, the Department of Health provided funding for numerous drought-related drinking water activities, including allowing construction of emergency wells and pipelines; adding, deepening or re-drilling wells; creating inter-ties between several water purveyors; and replacing leaking water mains.

Potential impact on fish habitat

The Department of Fish and Wildlife worked with local, tribal, and federal fisheries biologists to determine which streams might face low stream flow and to develop mitigation strategies to allow the passage of migrating salmon. The department took no action on many of the identified projects because of a cool summer, timely rainfall and improved stream flows. Several projects improved adult fish passage, including removing impediments in streams, removing weeds, and constructing flumes and other flow improvement measures.

Low flows in some small streams led to the uncovering of some salmon nests that stranded eggs; the impact on future salmon runs is yet to be determined.

Potential impact on forests

While spring rains tempered the drought somewhat, fuel moisture levels remained abnormally low, particularly in high elevation areas that lacked normal snow pack cover. Overall, 2005 weather patterns contributed to an active but relatively short wildfire season, concentrated during July and August. The number of wildfires was about 75 percent of average for the previous five years, but the acreage burned was three times greater. The largest – the School fire – burned 52,000 acres of state-protected lands, 109 homes and 106 other buildings, and cost of more than $15 million to put out. The fire also destroyed half of the elk and bighorn sheep and a third of the deer in the Tucannon Game Management Unit.

Impact of Drought on the Washington's Agriculture Industry[12, 13, 14]

Agriculture is the industry most heavily affected by drought. Most of Washington's crops grow in near-desert conditions in Eastern Washington and depend on irrigation; three-

quarters of the water consumed in Washington is used for irrigating crops, according the U.S. Geological Survey.

The state's food and agriculture industry support more than 180,000 jobs around the state and generates 13 percent of the state economy. Almost 70 percent of Washington's crop value – about $3.6 billion – comes from the 27 percent of harvested cropland that is irrigated. This includes the most valuable crops: apples, cherries, other tree fruit, vegetables, onions and potatoes. Per acre, irrigated crops are worth almost seven times more than crops from non-irrigated land. The tree fruit industry is the largest single user of irrigation water.

According to the 2005 and 2006 production estimates from the U.S. Department of Agriculture, Washington is the top producer of apples and pears in the nation, is number-two producer of sweet cherries, plums, prunes and potatoes, and seventh-ranked producer of vegetables.

Drought can affect the agriculture industry in a number of ways:

- It reduces crop production, sometimes for several years. This occurred in droughts of 1902, 1919, 1921, 1924, 1925, 1930, 1934, 1936, 1944, 1952, 1964, 1973, 1976, 1977, 1988, 1992.

- It reduces availability of food on rangeland for grazing animals. This occurred in droughts of 1902, 1930, 1935, 1936, 1966, 1967, 1988, 1992.

- It eliminates jobs in the field, at food processing plants and in affiliated facilities. Washington is a leader in the processing of fruits, vegetables, dairy products and seafood. The latest gross sales estimate for food processing in Washington is $8.9 billion annually.

- It reduces availability of relatively inexpensive hydropower for farmers, processors, and storage facilities, increasing their reliance on more expensive energy sources. For food processors, 30 to 40 percent of the cost of processing and cold storage is for energy. Higher energy costs caused by drought remove their competitive edge.

- It increases shipping costs for some segments of the industry. For example, wheat growers may have to use truck and rail transport for a portion of their crop if the level of the Snake and Columbia Rivers become too low for barge traffic. Sixty percent of Washington wheat moves down these rivers. The impact goes beyond Washington, as 42 percent of all U.S. grains are shipped via the Columbia River, including half of Nebraska's corn and 25 percent of wheat from Kansas.

The impact of drought varies by region, by crop, and by the status of the irrigation water right holder (junior or senior). Loss of water is far more damaging to perennial crops,

such as fruit trees, grapes, hops, and asparagus, than to annual crops because it takes perennials a number of years to return to normal production. Reducing irrigation on annuals such as corn, peas, and other vegetables not only results in loss of a crop for a year, but it also may result in the loss of the food-processing infrastructure because of lack of product or higher costs for hydropower or other energy source.

Projected Economic Impact of 2001 Drought on Agriculture

In examining the impact of the 2001 drought, the Washington Department of Agriculture determined the potential long-term economic impact of cutting off water to a group of irrigators was five times the value of the lost harvest.

The analysis examined the production of 330 farmers that irrigated and harvested nearly 38,000 acres of cropland in the Columbia-Snake River region. The analysis assumed:

- The farms would not receive sufficient water to maintain their plants for one year.
- Annual crop farmers, representing about 70 percent of the acres, suffered a single year loss.
- Perennial-crop farmers (apples, cherries, grapes, etc.) lost production for three to seven years.

Table 2, below, shows the value of the economic loss for these farmers was projected at $1.2 billion, with projected annual job losses ranging from 2,144 the first year to 643 in subsequent years; each $1 million in lost economic activity represents approximately 15 jobs.

Table 2. Economic Impact of Drought on 330 Irrigators in Columbia-Snake System

Year	Acres Affected	Value Lost Harvest		Replanting Cost		Total Direct Loss (millions)	Job Loss			Total Economic Loss (millions)
		Harvest/ Acre	Value (millions)	Cost/ Acre	Value (millions)		On Farm	Related Jobs	Annual Total	
2001	37,806	$1,755	$66.3	$350	$4.0	$70.3	991	1,153	2,144	$331.7
2002	11,342	$4,000	$45.4	$9,638	$109.3	$154.7	297	346	643	$226.8
2003	11,342	$4,000	$45.4	$858	$9.7	$55.1	297	346	643	$226.8
2004	11,342	$4,000	$45.4	$750	$8.5	$53.9	297	346	643	$226.8
2005	11,342	$4,000	$45.4	$184	$2.1	$47.5	297	346	643	$226.8
Total Harvest Loss			**$247.8**		**$133.6**	**$381.4**				**$1,239.1**

Source: Washington Department of Agriculture, *The Impact of the 2001 Drought on Washington Agriculture*.

Jurisdictions Most Vulnerable to Drought[15]

Vulnerability to drought is affected by (among other things) population growth and shifts, urbanization, demographics, technology, water use trends, government policy, social behavior, environmental awareness, and economic ability to endure a drought. These factors evolve, and a community's vulnerability to drought may rise or fall in response to these changes. For example, increasing and shifting populations put greater pressure on water and other natural resources – more people need more water.

For the State Hazard Mitigation Plan, a county is most vulnerable to drought if it meets at least five of the following seven criteria:

- History of severe or extreme drought conditions:
  - The county must have been in serious or extreme drought at least 10-15 percent of the time from 1895 to 1995.

- Demand on water resources based on:
  - Acreage of irrigated cropland. The acreage of the county's irrigated cropland must be in top 20 in the state.
  - Percentage of harvested cropland that is irrigated. The percentage of the county's harvested cropland that is irrigated must be in top 20 in the state
  - Value of agricultural products. The value of the county's crops must be in the top 20 in the state.
  - Population growth greater than the state average. The county's population growth in 2000-2006 must be greater than state average of 8.17 percent.

- A county's inability to endure the economic conditions of a drought, based on:
  - The county's median household income less than 75 percent of the state median income of $51,749 in 2005.
  - The county classified as economically distressed in 2005 because its unemployment rate was 20 percent greater than the state average from January 2002 through December 2004.

The following counties meet the above criteria (supporting data is in the tables 3 through 8, following pages):

Adams Benton Chelan Franklin Grant
Kittitas Klickitat Okanogan Yakima

Counties Most At-Risk and Vulnerable to Drought

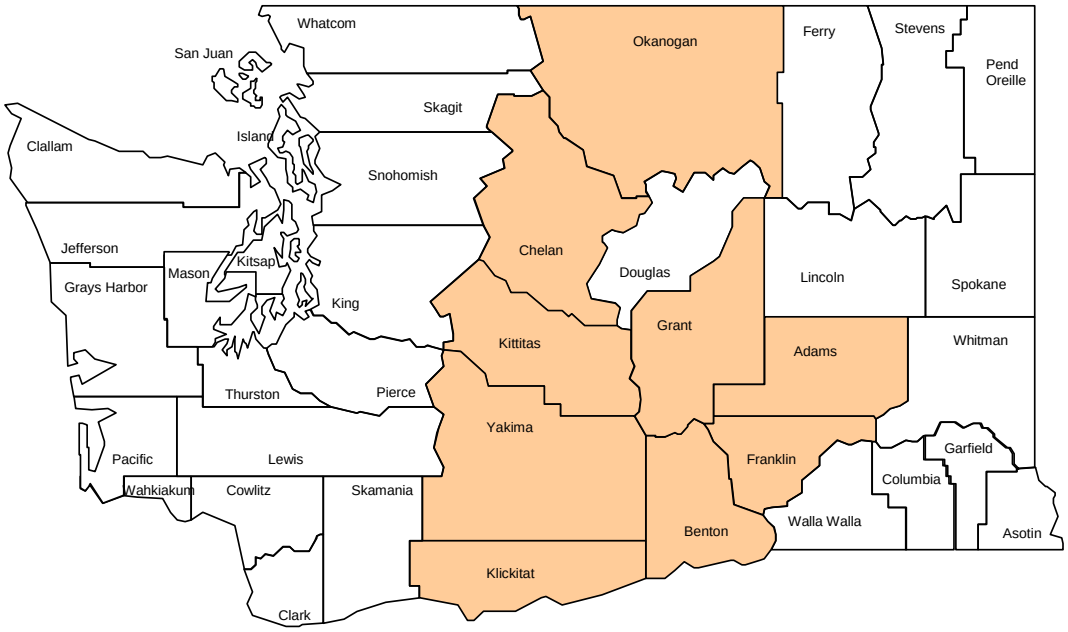


Table 3. Jurisdictions Most Vulnerable to Drought

County	% Time in Serious or Extreme Drought, 1895-1995	Acres Irrigated Cropland (State Rank)		% Harvested Cropland Irrigated (State Rank)		Market Value of Crops (State Rank)		Population Growth 2000 – 2006 (State Average = 8.17%)	Median Household Income ≤75% State Average of $51,749	Distressed County (Unemployment ≥120% State Average)
Adams	10-15%	120,746	(5)	30.4%	(18)	$156,732,000	(6)	5.31%	$35,657	YES
Benton	10-15%	188,340	(4)	70.1%	(6)	$366,342,000	(3)	12.72%	$53,354	NO
Chelan	10-15%	34,705	(10)	94.8%	(3)	$164,518,000	(5)	5.23%	$41,778	NO
Franklin	10-15%	241,063	(3)	83.4%	(4)	$297,450,000	(4)	30.10%	$41,176	NO
Grant	10-15%	485,459	(1)	80.9%	(5)	$626,501,000	(1)	7.90%	$39,155	YES
Kittitas	10-15%	91,944	(7)	137.8%	(1)	$38,432,000	(18)	12.1%	$34,669	NO
Klickitat	10-15%	25,280	(12)	26.2%	(21)	$40,215,000	(17)	3.33%	$37,728	YES
Okanogan	10-15%	48,416	(9)	68.0%	(7)	$116,551,000	(10)	0.60%	$32,908	YES
Yakima	10-15%	269,127	(2)	104.3%	(2)	$508,254,000	(2)	4.14%	$39,022	YES

Sources: National Drought Mitigation Center; *2002 Census of Agriculture*, U.S. Department of Agriculture; *April 2006 Population Estimates*, Office of Financial Management; *Median Household Income, 2005 Projection*, Office of Financial Management, October 2005; *Distressed Counties List*, Washington Department of Employment Security, October 2005.

History of Drought in Washington State

According to the National Drought Mitigation Center at the University of Nebraska-Lincoln, the Pacific Northwest region (Columbia, Willamette, and Snake River basins of Idaho, Oregon, and Washington, and portions of Montana and Wyoming) experiences drought more frequently than most other regions of the nation.

For purposes of examining drought frequency from 1895 through 1995, the drought center divided the nation into 18 regions generally corresponding to major river basin drainages. The Palmer Drought Severity Index, a measure of moisture supply, is used to determine drought conditions. The index determines that an area with a -3.0 to -3.99 rating is in severe drought, while an area with a -4.0 or greater rating is in extreme drought.

Figures produced by the National Drought Mitigation Center show that the Pacific Northwest had 10 percent or more of its area in severe or extreme drought during 61 years of the 100-year period. Only the Missouri basin of the north-central United States and the Great Basin of Nevada and Utah had more years with 10 percent or more of its area experiencing severe or extreme drought, 70 years and 65 years, respectively.

When severe or extreme drought covered a third of its area, the Pacific Northwest was in this condition 33 years of the 100-year period. Only two other regions had a third of their areas in drought more often than the Pacific Northwest – the Great Basin (37 years) and the Upper Colorado (34 years). The Missouri basin also was in this condition 33 years out of the 100-year period.

When severe or extreme drought covered two thirds of its area, the Pacific Northwest was in this condition 14 years out of 100. Again, only two other regions – the Upper Colorado (25 years) and Tennessee (16 years) – were in this condition more frequently than the Pacific Northwest.

Drought affects all areas of the state, but at different levels; the wetter, west side of the state experiences drought conditions less often, and less severely, than does the drier, east side of the state.

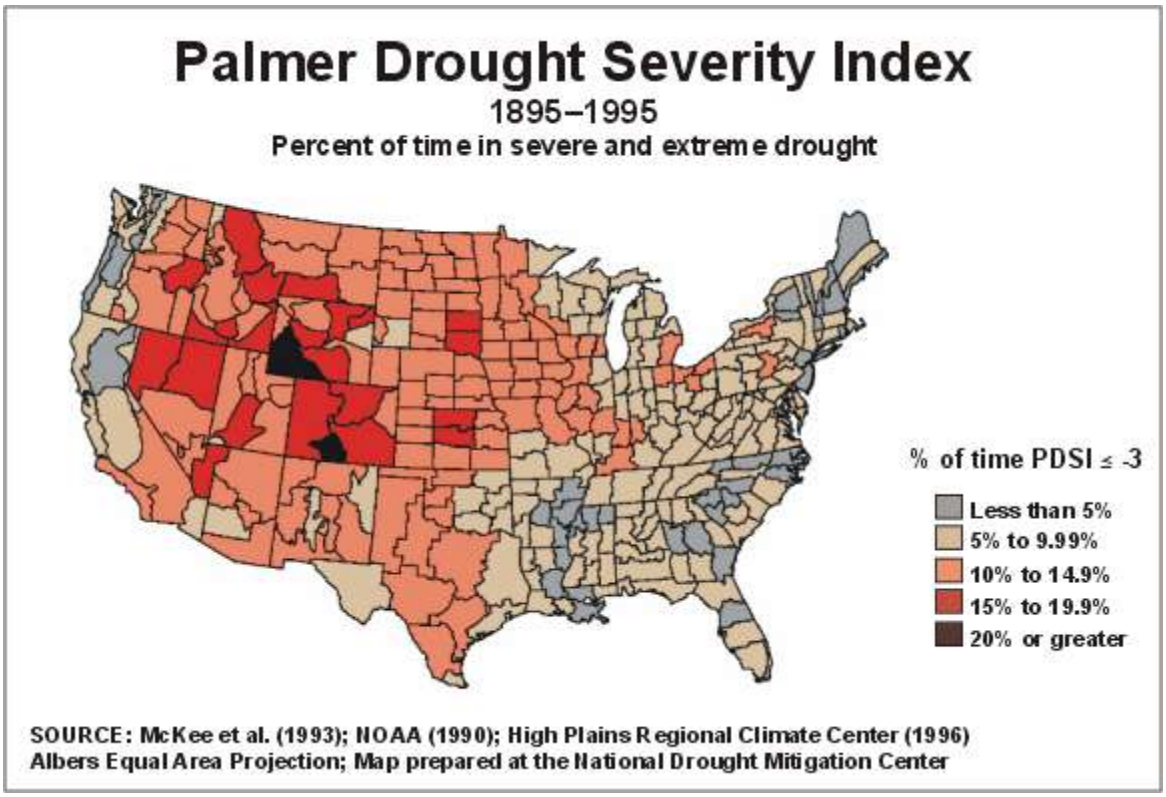
During 1895-1995, much of the state was in severe or extreme drought at least 5 percent of the time. All of Eastern Washington, except for the Cascade Mountain's eastern foothills, was in severe or extreme drought (See Palmer Drought Severity Index 1895-1995 map, page 16) 10 to 15 percent of the time. The east slopes of the Cascades and much of Western Washington was in severe or extreme drought from 5 to 10 percent of the time.

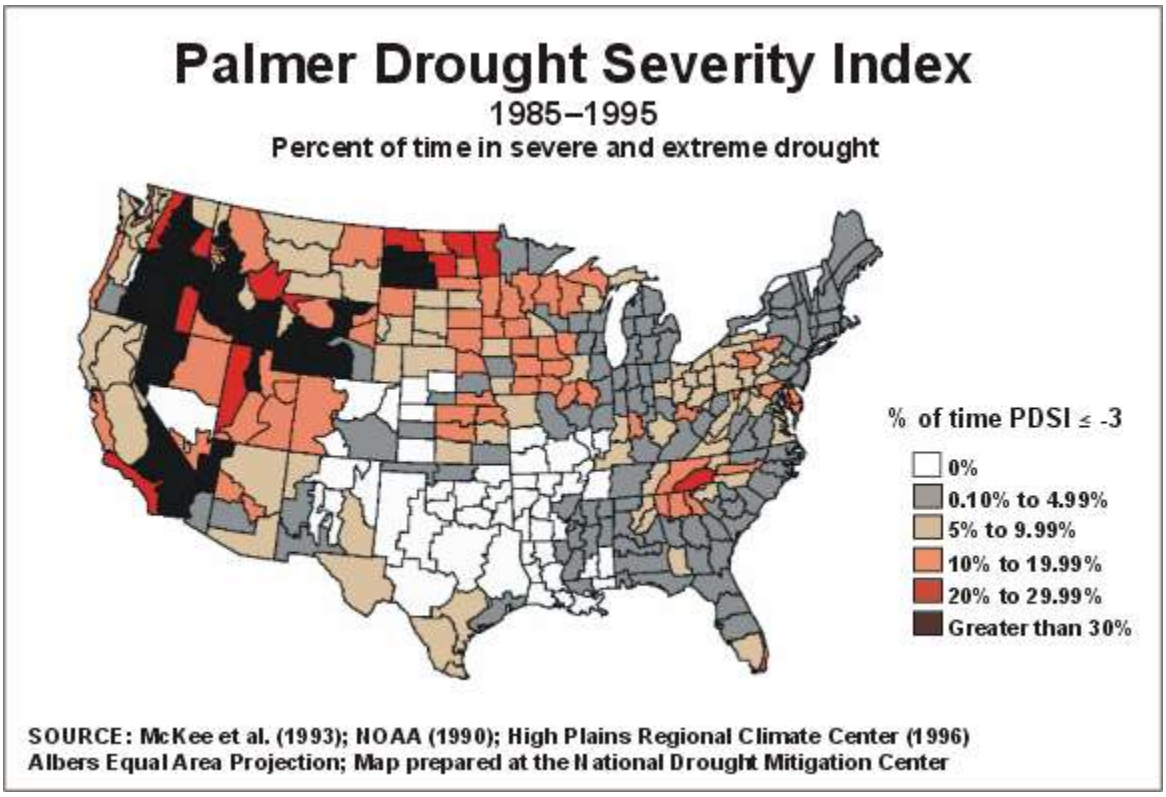
Many of the same counties experienced serious or extreme drought conditions from 1985 to 1995 and during the 1977 drought episode. Table 4, page 15, shows how much time each of Eastern Washington's counties has been in serious or extreme drought:

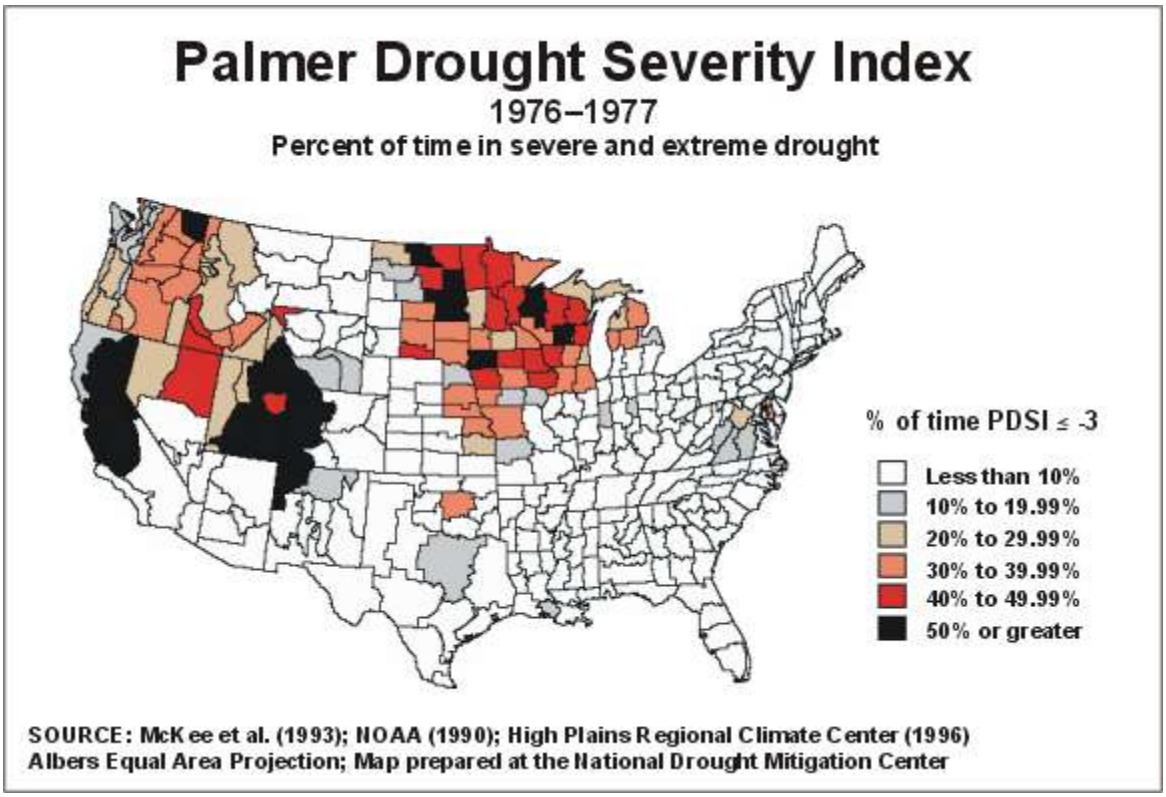
Table 4. Serious or Extreme Drought Conditions in Washington Counties

County	% Time in Drought 1895-1995	% Time in Drought 1985-1995	% Time in Drought 1976-77
Adams	10-15%	20-30%	30-40%
Asotin	10-15%	20-30%	30-40%
Benton	10-15%	> 30%	30-40%
Chelan	10-15%	> 30%	30-40%
Columbia	10-15%	20-30%	30-40%
Douglas	10-15%	> 30%	30-40%
Ferry	10-15%	5-10%	> 50%
Franklin	10-15%	20-30%	30-40%
Garfield	10-15%	20-30%	30-40%
Grant	10-15%	> 30%	30-40%
Kittitas	10-15%	> 30%	30-40%
Klickitat	10-15%	> 30%	30-40%
Lincoln	10-15%	20-30%	30-40%
Okanogan	10-15%	> 30%	> 50%
Pend Oreille	10-15%	5-10%	> 50%
Spokane	10-15%	20-30%	30-40%
Stevens	10-15%	5-10%	> 50%
Walla Walla	10-15%	20-30%	30-40%
Whitman	10-15%	20-30%	30-40%
Yakima	10-15%	> 30%	30-40%

Source: *National Drought Mitigation Center*, see maps below.


Palmer Drought Severity Index
1895–1995
Percent of time in severe and extreme drought
% of time PDSI ≤ -3
Less than 5%
5% to 9.99%
10% to 14.9%
15% to 19.9%
20% or greater
SOURCE: McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)
Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center


Palmer Drought Severity Index
1985–1995
Percent of time in severe and extreme drought
% of time PDSI ≤ -3
0%
0.10% to 4.99%
5% to 9.99%
10% to 19.99%
20% to 29.99%
Greater than 30%
SOURCE: McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)
Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center


Palmer Drought Severity Index
1976–1977
Percent of time in severe and extreme drought
% of time PDSI ≤ -3
Less than 10%
10% to 19.99%
20% to 29.99%
30% to 39.99%
40% to 49.99%
50% or greater
SOURCE: McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)
Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center

Irrigated Cropland

Table 5, below, shows the 20 counties that irrigate the greatest percentage of their harvested cropland, and the total value of their harvested crops.

Table 5. Top 20 Irrigation Counties in Washington State

County	Acres of Harvested Cropland	Acres of Irrigated Cropland	% of Cropland Irrigated	Market Value of Harvested Crops	National Ranking Harvested Crop Value **
Kittitas *	66,711	91,944	137.8%	$38,432,000	
Yakima *	257,921	269,127	104.3%	$508,254,000	16
Chelan	36,618	34,705	94.8%	$164,518,000	61
Franklin	288,963	241,063	83.4%	$297,450,000	29
Grant	599,943	485,459	80.9%	$626,501,000	12
Benton	268,690	188,340	70.1%	$366,342,000	22
Okanogan	71,149	48,416	68.0%	$116,551,000	94
Clallam	7,763	4,691	60.4%	not available	
Whatcom	70,065	31,864	45.5%	$75,998,000	
Pierce	14,038	6,324	45.0%	$34,963,000	
Skamania	1,171	475	40.6%	$1,603,000	
Grays Harbor	13,480	5,266	39.1%	$13,936,000	
Thurston	17,720	6,634	37.4%	$49,331,000	
Cowlitz	8,536	3,093	36.2%	$10,848,000	
Pacific	7,819	2,830	36.2%	$4,315,000	
Ferry	11,705	4,184	35.7%	$920,000	
King	10,165	3,565	35.1%	$72,602,000	
Adams	397,171	120,746	30.4%	$156,732,000	67
Walla Walla	316,313	94,067	29.7%	not available	
Skagit	62,074	17,658	28.4%	$152,452,000	

* – Kittitas County and Yakima County irrigated cropland figure includes lands used for pasture, grazing, cover crops and other uses not directly related to harvested crops.

** – Top 100 Counties.

Source: *US Department of Agriculture, 2002 Census of Agriculture*.

Market Value of Crops, top 20 counties

Table 6, below, shows the market value of crops produced in the top agricultural counties of the state, and their rank by value.

Table 6. Market Value of Crops, Top 20 in Washington State

County	Market Value	State Rank
Grant	$626,501,000	1
Yakima	$508,254,000	2
Benton	$366,342,000	3
Franklin	$297,450,000	4
Chelan	$164,518,000	5
Adams	$156,732,000	6
Whitman	$155,249,000	7
Skagit	$152,452,000	8
Douglas	$118,186,000	9
Okanogan	$116,551,000	10
Lincoln	$85,209,000	11
Spokane	$77,263,000	12
Whatcom	$75,998,000	13
King	$72,602,000	14
Snohomish	$57,961,000	15
Thurston	$49,331,000	16
Klickitat	$40,215,000	17
Kittitas	$38,432,000	18
Pierce	$34,963,000	19
Clark	$28,475,000	20

Source: *2002 Census of Agriculture,* US Department of Agriculture

Counties Growing Faster Than State Average, 2000-2006

The U.S. Geological Survey's water use figures for Washington State show that public supply – domestic, commercial, industrial, and thermoelectric generation – uses about one gallon of every eight.

Growing counties will find their rate of water use grow with as their population grows. Table 7, below, shows the counties showing the top rates of population growth between 2000 and 2006; those above the state's growth rate of 8.17 percent likely will experience a greater demand for water than the state average.

Table 7. Population Growth

County	Average Growth 2000-2006
Franklin	30.10%
Clark	16.88%
Benton	12.72%
Kittitas	12.10%
San Juan	11.53%
Thurston	11.45%
Snohomish	10.85%
Whatcom	10.47%
Pierce	10.37%
Skagit	9.83%
Douglas	9.50%
State Average	*8.17%*
Grant	7.90%
Island	7.88%
Mason	7.48%
Skamania	7.37%
Jefferson	7.23%
Lewis	6.27%
Spokane	6.19%
King	5.66%
Clallam	5.64%

Source*:* Office of Financial Management Forecasting Division, June 2006*.*

Household Income of Counties, 2005

Table 8, below, shows those counties whose median household income is less than or equal to 75 percent of the state median income in 2005. Median income is that income level at which half of the household incomes in the county are larger and half are smaller.

Table 8. Median Household Income ≤ 75% of State Average

State Average	*$44,776*
75% State Average	*$34,332*
Klickitat	$34,267
Grays Harbor	$34,160
Adams	$33,888
Asotin	$33,524
Columbia	$33,500
Garfield	$33,398
Kittitas	$32,546
Pend Oreille	$31,677
Pacific	$31,209
Ferry	$30,388
Okanogan	$29,726
Whitman	$28,584

Source: Office of Financial Management, Forecasting Division, October 2005

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Economically Distressed Counties, 2005

Table 9, below, lists the counties classified as economically distressed in 2005, based on their unemployment rate being at least 20 percent greater than the state's average unemployment rate during the January 2002 – December 2004 period.

Table 9. Economically Distressed Counties, 2005

County	Unemployment Rate
State Average	*7.0%*
State Average plus 20 percent	*8.4%*
Ferry	11.6%
Klickitat	10.8%
Cowlitz	9.7%
Skamania	9.6%
Pend Oreille	9.5%
Stevens	9.3%
Yakima	9.3%
Columbia	9.2%
Okanogan	9.1%
Grays Harbor	9.0%
Lewis	9.0%
Grant	8.9%
Wahkiakum	8.8%
Adams	8.7%
Clark	8.7%
Pacific	8.7%

Source: Washington Department of Employment Security, Labor Market and Economic Analysis Branch, October 6, 2005.

[1] *Washington State 2001 Hazard Identification and Vulnerability Assessment*, Washington State Military Department, Emergency Management Division, April 2001.

[2] Curt Hart, et al., *2001 Drought Response, Report to the Legislature*, Washington Department of Ecology Water Resources Program, Publication No. 01-11-017, December 2001.

[3] *Planning for Drought: Why Plan for Drought*, National Drought Mitigation Center, University of Nebraska – Lincoln, <http://www.drought.unl.edu/plan/whyplan.htm>, (April 2, 2003).

[4] *Science of Drought*, Washington Department of Ecology Water Resources Program, <http://www.ecy.wa.gov/programs/wr/drought/droughtscience.html>, (April 2, 2003).

[5] *Focus: Drought in Washington State*, Washington Department of Ecology, 2001, <http://www.ecy.wa.gov/pubs/0111003.pdf>, (June 20, 2003).

[6] *2003 Biennial Energy Report – Energy Strategy Update: Responding to the New Electricity Landscape*, Washington Department of Community Trade and Economic Development, Energy Policy Division, February 2003.

[7] *What is Drought: Predicting Drought*, National Drought Mitigation Center, University of Nebraska – Lincoln, < http://www.drought.unl.edu/whatis/predict.htm>, (April 2, 2003).

[8] Mary Getchell, *Drought Update: Final Review of the 2001 Drought*, Washington Department of Ecology, news release 01-168, September 25, 2001, <http://www.ecy.wa.gov/news/2001news/2001-168.html>, (April 2, 2003).

[9] Curt Hart, et al., *2001 Drought Response, Report to the Legislature*, Washington Department of Ecology Water Resources Program, Publication No. 01-11-017, December 2001.

[10] Ibid.

[11] *2005 Drought Response – Report to the Legislature*, Washington Department of Ecology, Publication # 06-11-001, February 2006

[12] Ibid.

[13] *Estimated Use of Water in the United States in 1995,* Circular 1200, U.S. Geological Survey, 1998.

[14] William E. Brookreson and Linda Crerar, *The Impact of the 2001 Drought on Washington Agriculture*, Washington Department of Agriculture, April 3, 2001.

[15] *Planning for Drought: Why Plan for Drought*, National Drought Mitigation Center, University of Nebraska – Lincoln, <http://www.drought.unl.edu/plan/whyplan.htm>, (April 2, 2003).